



CAL Document Change Notification

DCN No.
7650-DCN-0089-01

CHANGE TITLE: Updates To Cal Mass Properties Test Procedure

Internal External

ORIGINATOR: Paul Dizon

DATE: 17-Nov-04

NEXT ASSY: N/A

| DOC or DWG NUMBER | TITLE | AFFECTED REV. | NEW REV. |
|-------------------|---|---------------|----------|
| LAT-DS-04648 | Cal Mass Properties Measurement Procedure | 01 | 02 |
| | | | |
| | | | |
| | | | |
| | | | |

CHANGE DESCRIPTION:

1) Section 2.6 EQUIPMENT AND SUPPLIES

Add: Scale - 500 lb capacity, +/-0.1 lb resolution, QTY = 1

2) Section 2.7 PARTS LIST

Remove first item, PEM Assembly Platform

3) Section 3.1 WEIGHING OPERATIONS

Remove the following components to be weighed (Side Panels, EMI Gaskets, Associated Fasteners), which are not necessary with the final measured weight. Reword sentence to accomodate change.

REASON FOR CHANGE:

Updated based on as-run procedure from FM 101

DISPOSITION OF HARDWARE:

No hardware affected

Serial numbers affected: FM 102 - FM 118

Effective date: 17-Nov-04

| | Use as is | Retest | Rework | Scrap | Other/Comment |
|------------------|-----------|--------|--------|-------|---------------|
| Raw material | | | | | |
| Parts in process | | | | | |
| Assemblies | | | | | |

| APPROVALS | | DATE | OTHER APPROVALS (specify): | DATE |
|--------------------------|----------------------|-----------|----------------------------------|-----------|
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CAL Document Change Notification

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Continuation:

4) SECTION 4.1.1 Weighing of Non-CAL Module Components

Remove the following components from table to be weighed, which are not necessary with the final measured weight.
Change part number of M6 socket head cap screw and washer to NA0069-060024 and A370-903-32

5) SECTION 4.1.2 Weighing of CAL Tower Module:

Step 1 - change Turn-Over Dolly to CAL Tower Module

Step 2 - change Turn-Over Dolly to ground

Step 3 - modify table - remove the following parts (LAT-DS-02795, LAT-DS-04537, fasteners and covers) since they are redundant with the assemblies listed

Step 5 - Step 18 - delete and replace according to following:

a) Step 5 - Attach the Hoist Ring of the Lifting Fixture Assembly to the CAL Tower Module

b) Step 6 - Position the CAL Tower Module underneath the A-Frame or Hoist.

c) Step 7 - Attach CAL Lifting Fixture Assembly (LAT-DS-04138) to hoist.

d) Step 8 - Attach a second certified grounding strap to the Hoist Plate.

e) Step 9 - Disconnect the grounding strap from the CAL Tower Module.

f) Step 10 - Lower and attach the Lifting Fixture Assembly onto the Hoist Plate. Reduce the slack in the shackles, but do not load the hoist.

g) Step 11 - Verify that the scale is powered on and zeroed.

h) Step 12 - Lift the CAL Tower Module and slowly lower it onto the scale until Lifting Fixture Assembly is off-loaded.

Disconnect Lifting Fixture Assembly from hoist.

i) Step 13 - Record the weight below.


Weight = _____ lbs. = _____ kg

j) Step 14 - Lift the CAL Tower Module until it is clear of the scale.

k) Step 15 - Lower the CAL Tower Module into the shipping container per LAT-PS-04237. Attach ground strap to the grounding lug on the shipping container and remove the second ground strap from the Hoist Plate.

6) SECTION 4.1.3 - Update table to reflect weights measured in Section 4.1.1, 4.1.2, MGSE assemblies



| | | |
|--|---|------------------------------------|
|  GLAST LAT PROCEDURE | Document # LAT-PS-04648-02 | Date Effective 17 November 2004 |
| | Prepared by(s) Lisa J. Gelston | Supersedes LAT-PS-04648-01 |
| | Subsystem/Office Calorimeter Subsystem | |
| Document Title CAL Mass Properties Measurement Procedure | | |

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT) Calorimeter

Mass Properties Measurement Procedure

**MASTER
DOCUMENT**
17 NOV 2004
**GLAST-CAL CM
FILE COPY**

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

| Revision | Effective Date | Description of Changes |
|-----------------|-----------------------|--|
| 01 | 01 September 2004 | Initial Release |
| 02 | 17 November 2004 | Updates per as-run redlines from procedure used for weighing of FM 101 |
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1 INTRODUCTION

1.1 PURPOSE

This document describes the procedure required to measure the mass properties (weight and center of gravity) of the GLAST Calorimeter (CAL) Module.

1.2 APPLICABLE DOCUMENTS

Documents and drawings that are applicable to this procedure are listed below.

| | |
|--------------|---|
| LAT-DS-00916 | CAL Module |
| LAT-DS-01224 | CAL Pre-Electronics Module |
| LAT-DS-04536 | CAL Tower Module |
| LAT-DS-04138 | CAL Lifting Fixture |
| LAT-DS-04537 | CAL Handling Fixture |
| LAT-MD-00228 | GLAST LAT CAL, TKR, and T&DF Contamination Control Plan |
| LAT-PS-04237 | CAL Module Handling Procedure |
| LAT-SS-00238 | Interface Control Document between the Calorimeter Subsystem and LAT Instrument |

1.3 DEFINITIONS AND ACRONYMS

| | |
|-------|--------------------------------------|
| CAL | Calorimeter Subsystem of the LAT |
| CDE | Crystal Detector Element |
| CG | Center of Gravity |
| GLAST | Gamma-Ray Large Area Space Telescope |
| LAT | Large Area Telescope |
| PEM | Pre-Electronic Module of the CAL |
| PR | Problem Record |
| QA | Quality Assurance |
| TBD | To Be Defined |

2 GENERAL REQUIREMENTS

2.1 MASS PROPERTIES

2.1.1 Mass

The maximum CAL Module mass allocation is 90 kg. The maximum allowable mass variation among CAL modules shall be +/- 2 kg.

2.1.2 CAL Module Center of Gravity

The maximum X/Y center of gravity (CG) offset from the geometric center of a CAL module is +/- 10 mm.

The maximum Z CG position from the CAL-grid interface is 116 mm.

2.2 PERSONNEL

All operations involving weighing and CG measurement shall be performed by a qualified operator knowledgeable in the use of the overhead crane, A-Frame hoist, and CAL Lifting Fixture specified in this procedure. Furthermore, only personnel trained in proper ESD procedures shall be allowed to participate in handling activities.

2.3 ENVIRONMENT

Environmental conditions are defined in the Calorimeter, Tracker, & Data Acquisition Contamination Control Plan, LAT-MD-00228. Depending on the assembly flow of the CAL Tower Module, weighing and CG measurement operations for the CAL Tower Module and Pre-Electronics Module (PEM) will be performed in a clean room environment with the conditions defined below:

- Temperature: 20°C to 25°C
- Relative Humidity: 35% RH to 50% RH
- Cleanliness: Class 100,000 or better

However, some weighing operations, such as weighing of assembly components or weighing of the CAL Tower Module during environmental testing, may not occur in a clean room environment. These operations shall be performed in the following environmental conditions defined below:

- Temperature: 20°C to 25°C
- Relative Humidity:
 - CAL Tower Module 35% RH to 50% RH (50% RH to 55% RH for up to 3 hours)
(Test Article to be bagged where RH requirements cannot be met)
 - Assembly Components No RH requirement
- Cleanliness:
 - CAL Tower Module Test Article to be bagged where Class 100,000 is not available
 - Assembly Components No Cleanliness Requirement. Components must be cleaned before they can be admitted into the Clean Room

The Quality Assurance Engineer will control these conditions on a regular basis. Temperature and humidity shall be monitored continuously, where applicable, and operations shall be halted if conditions fail to meet these requirements.

2.4 OUTGASING AND CONTAMINATION

All materials used during the measurement of the mass properties shall meet the outgassing and contamination requirements specified in LAT-MD-00228. For operations occurring within the clean room, all personnel shall be trained in proper clean room etiquette and wear clean-room garments, including powder-free gloves. For operations outside of the clean room, all personnel shall wear, at a minimum, powder-free gloves during handling.

2.5 HANDLING AND SAFETY

All ESD precautions per NASA-8739.7 will be followed during operations involving the CAL Tower Module, Tower Electronics Module (TEM), and the TEM Power Supply (TPS). ESD precautions are not necessary for operations involving measurement of non-electrical assembly components outside of the clean-room unless these operations are in close proximity to the CAL Tower Module.

Only personnel trained in proper ESD procedures shall be allowed to participate in measurement activities. Personnel wrist straps shall be worn during all handling of the CAL Tower Module, PEM, TEM, and the TPS. These items as well as work tables and fixtures must be grounded to a common point.

Care must be taken so that no equipment or tools are allowed to rest, strike or bump any part of the CAL Module or its components. All loose objects such as pens, pencils, badges, etc, shall be removed from open pockets when working on or around the CAL Module.

All lifting equipment must have a current certified proof load test. During all overhead crane operations, a controlled area must be established to ensure that personnel are clear of the load at all times

In Section 4 of this document CAUTION and WARNING notes appear. In each case, the note appears above the section or step to which it refers. A CAUTION note describes a condition, which can be detrimental to flight hardware. A WARNING note describes a condition, which can present a risk to personnel.

2.6 EQUIPMENT AND SUPPLIES

The following equipment and supplies are required for the procedure:

- Scale – 500 lb capacity, +0.1 lb resolution, QTY = 1
- Load Cell – 500 lb capacity, +0.1 lb resolution, QTY = 5
- Load Cell Reader
- Associated Lifting Hardware
- Calibrated Torque Wrench
- Square drive Hex Bit for the following fasteners
- M4 Socket-Head Cap Screws
- Miscellaneous Hand Tools
- Powder-Free Gloves and Clean Room Garments
- Personal ESD wrist straps and ankle/foot straps
- Lint-Free Wipes and Swabs
- Acetone
- Isopropyl Alcohol

2.7 PARTS LIST

| DRAWING NUMBER PART NUMBER | PART DESCRIPTION | QUANTITY |
|-------------------------------|--|----------|
| LAT-DS-04138 | CAL Lifting Fixture Assembly | 1 |
| LAT-DS-02795 | Hoist Plate, Calorimeter | 1 |
| LAT-DS-04537 | CAL Handling Fixture Assembly | 1 |
| LAT-DS-01524 | Base Plate, Handling Fixture | 1 |
| LAT-DS-05952 | Post, Handling Fixture | 4 |
| BN 40112 | Screw, Flange Socket-Head, M4 x 0.45 (20 mm L) | 16 |

3 WEIGHT AND CENTER OF GRAVITY MEASUREMENT PLAN

Measurement of the mass properties for the CAL consists of the following operations:

- Weighing operation for all CAL Modules
- Center of Gravity measurement for one PEM

Because of the assembly flow, the CAL Module will never be in the complete CAL Module configuration until after it is assembled into the CAL Tower Module. Therefore, the weight and CG of the CAL Module cannot be measured directly. Weighing and CG measurement operations can only take place when the CAL is in various configurations during assembly, as shown in Figure 3-1.

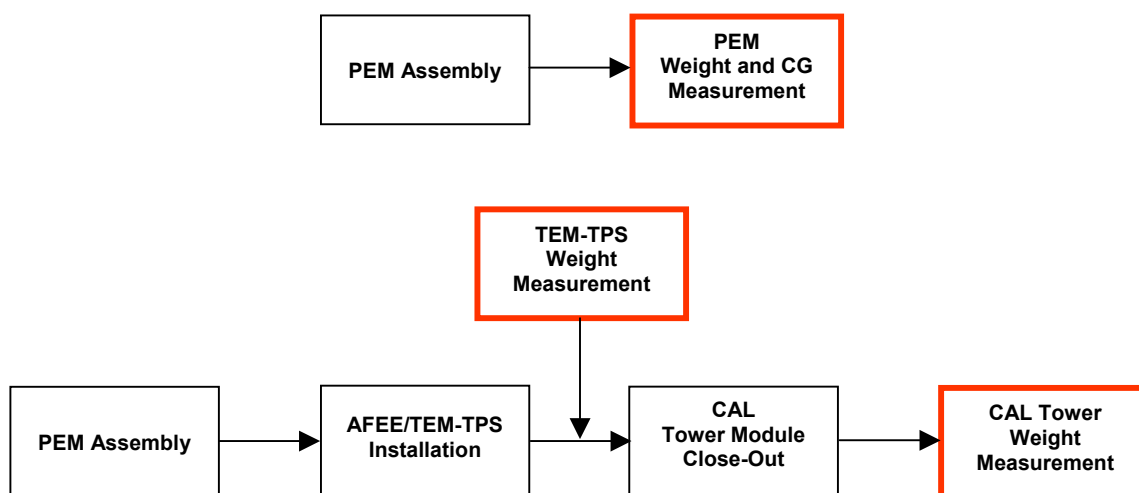


Figure 3-1: Mass Properties Measurement Flow

3.1 WEIGHING OPERATION

Because of the assembly flow, the weight of the CAL Module cannot be measured until after it is already assembled into the CAL Tower Module configuration. Since the weight of the CAL Module cannot be directly measured, all CAL Tower Module components that are not considered part of the CAL Module (Tower Electronics Module - TEM Power Supply Assembly and associated hardware) must be weighed before integration so that an accurate weight of the CAL Module can be determined.

3.2 CENTER OF GRAVITY MEASUREMENT

Because of the assembly flow, the CG of the CAL Module cannot be measured until the EM2 TEM-TPS is removed from the CAL Module. This event will not take place until after the CAL Module is delivered for integration into the Large Area Telescope (LAT). As a result, the CG of the CAL Module cannot be directly measured. However, it was determined that accurate CG measurements can still be measured when the CAL Module is in the PEM configuration due to the fact that: 1) the missing components only make up 2.5% of the total mass of the CAL Module and; 2) that these components are symmetrically located around the Z-Axis of the CAL Module.

4 PROCEDURE

Measurement of the mass properties for the CAL consists of the following operations:

- Weighing operation for all CAL Modules
- Center of Gravity measurement for one PEM

4.1 WEIGHING OPERATION

Weighing operations are divided into three separate events:

- Weighing of the CAL Tower Module Parts not considered part of the CAL Module
- Weighing of the CAL Tower Module
- Calculation of the CAL Module weight

4.1.1 *Weighing of Non-CAL Module Parts:*

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed.

**Work Table and Fixtures shall be grounded with 1-10 MOhm Resistor
(QA will verify connection).**

Only personnel wearing ESD protection should be present during operations.

1. If applicable according to the ESD Handling and Safety requirements from Section 2.5
 - Verify that a certified grounding strap is connected to the associated electrical component.
 - Attach personal wrist strap to a common ground point.
2. Weigh the following items and record:

| PART NUMBER | PART DESCRIPTION | S/N | QTY | WEIGHT (lb) |
|------------------------|--------------------------------|-----|-----|----------------|
| LAT-DS-00995 | TEM-TPS Assembly | | 1 | |
| NA0069-060024 | Screw, Socket-Head, M6 (24 mm) | | 4 | |
| A370-903-32 | Washer, Flat, M6 | | 4 | |
| Total TEM-TPS Weight = | | | | |

4.1.2 Weighing of CAL Tower Module:

The weight of each CAL Tower Module is measured as defined in the following procedural steps:

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed.

**Work Table and Fixtures shall be grounded with 1-10 MOhm Resistor
(QA will verify connection).**

Only personnel wearing ESD protection should be present during operations.

WARNING

**During Lift Operations, a controlled area must be established to
ensure that personnel are clear of the load at all times.**

1. Verify that a certified grounding strap (with 1-10 MOhm resistor) is connected to the CAL Tower Module.
2. Attach personal wrist strap to ground.
3. Weigh the following MGSE items and record:

| PART NUMBER | PART DESCRIPTION | S/N | QTY | WEIGHT (lb) |
|----------------------------|---|-----|-----|----------------|
| LAT-DS-04138 | CAL Lifting Fixture Assembly (with fasteners) | | 1 | |
| LAT-DS-01524 | Base Plate, Handling Fixture | | 1 | |
| LAT-DS-05952 | Post, Handling Fixture (with fasteners) | | 4 | |
| Total MGSE Weight = | | | | |

4. Verify that PDU/GASU Cables have been disconnected from the TEM-TPS. Install ESD covers over the sockets if they are missing.
5. Attach CAL Lifting Fixture Hoist Plate (LAT-DS-02795) to the Top Frame of the CAL Tower Module using sixteen M4 socket-head cap screws. Tighten fasteners to 10 in-lb \pm 1 in-lb.
6. Position the CAL Tower Module underneath the A-Frame or Hoist.
7. Attach CAL Lifting Fixture Assembly (LAT-DS-04138) to hoist.
8. Attach a second certified grounding strap to the Hoist Plate.
9. Disconnect the grounding strap from the CAL Tower Module.
10. Lower and attach the Lifting Fixture Assembly onto the Hoist Plate. Reduce the slack in the shackles, but do not load the hoist.
11. Verify that the scale is powered on and zeroed.
12. Lift the CAL Tower Module and slowly lower it onto the scale until Lifting Fixture Assembly is off-loaded. Disconnect Lifting Fixture Assembly from hoist.

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be considered the latest revision.**

13. Record the weight below.

Weight = _____ lbs. = _____ kg

14. Lift the CAL Tower Module until it is clear of the scale.

15. Lower the CAL Tower Module into the shipping container per LAT-PS-04237. Attach ground strap to the grounding lug on the shipping container and remove the second ground strap from the Hoist Plate.

4.1.3 Calculation of CAL Module Weight

The weight of each CAL Module calculated using the following worksheet:

| PART NUMBER | PART DESCRIPTION | WEIGHT (lb) |
|---|------------------|----------------|
| CAL TOWER MODULE (FROM SECTION 4.1.2, STEP 13) | | |
| TEM-TPS ASSEMBLY SUBTOTAL (FROM SECTION 4.1.1) | | - () |
| MGSE SUBTOTAL (FROM SECTION 4.1.2, STEP 3) | | - () |
| Total CAL Module Weight = | | |

4.2 CENTER OF GRAVITY MEASUREMENT

The CG location of FM 101 is determined by calculation only. The calculation is verified using the following procedural steps:

4.2.1 Calculation of PEM Center of Gravity

The CG of the PEM is calculated using the following worksheets:

4.2.2 Measuring Center of Gravity Weight of PEM

CAUTION – ESD HAZARD - CAUTION

ESD precautions per NASA-STD-8739 shall be followed.

**Work Table and Fixtures shall be grounded with 1-10 MOhm Resistor
(QA will verify connection).**

Only personnel wearing ESD protection should be present during operations.

WARNING

**During Lift Operations, a controlled area must be established to
ensure that personnel are clear of the load at all times.**

1. Attach the CAL Lifting Fixture Assembly (LAT-DS-04138), minus the Hoist Plate (LAT-DS-02795) onto the hook of the hoist.
2. Position the PEM underneath the A-Frame and Hoist.
3. Verify that a certified grounding strap (with 1 – 10 MOhm resistor) is connected to the PEM Assembly Platform.
4. Attach personal wrist strap to the PEM Assembly Platform.
5. Attach CAL Lifting Fixture Assembly (LAT-DS-04138) to the Top Frame of the PEM using M4 socket-head cap screws. Tighten fasteners to 10 in-lb \pm 1 in-lb.
6. Attach another certified grounding strap to the Hoist Plate.
7. Attach personal wrist strap to the Hoist Plate.
8. Disconnect the certified grounding strap from the PEM Assembly Platform.
9. Attach the Lifting Fixture Assembly to the hoist. Reduce the slack in the shackles, but do not load the hoist.
10. Loosen and remove the nylon nuts securing the Shear Pins of the PEM onto the Corner Support of the PEM Insertion Tooling (LAT-DS-03321).
11. Using the hoist, slowly lift the PEM from the Base Platform of the PEM Insertion Tooling and verify that the Shear Pins of the PEM are not binding in the holes of the Corner Supports.
12. Lift the PEM above the table and remove all components of the PEM Insertion Tooling.
13. Clear PEM Insertion Tooling from the granite table .
14. Set up four load cells on the granite table directly underneath the shear pins of the PEM.
15. Verify that the load cell reader is powered on and zeroed.

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be considered the latest revision.**

16. Using the hoist, slowly lower the PEM onto the four load cells until Lifting Fixture Assembly is off-loaded. Disconnect the Hoist Plate from the PEM and lift the Lifting Fixture Assembly away from the PEM.
17. Record load cell reading from load cell reader in table below:

| | WEIGHT (+X, +Y) (lb) | WEIGHT (+X, -Y) (lb) | WEIGHT (-X, -Y) (lb) | WEIGHT (-X, +Y) (lb) |
|--|----------------------------|----------------------------|----------------------------|----------------------------|
| | | | | |

18. Slowly lift the PEM from the load cells until the load cell reader shows a zero reading.
19. Slowly lift the PEM from the load cells until the load cell reader shows a zero reading .
20. Secure the PEM onto its associated assembly or test fixture.
21. Disconnect CAL Lifting Fixture assembly and store.

4.2.3 Calculation of PEM Center of Gravity

The CG of the PEM is calculated using the following worksheets:

| LOAD CELL LOCATION | WEIGHT (lb) | X _{CG} (in) | Y _{CG} (in) | WT × X _{CG} (lb-in) | WT × Y _{CG} (lb-in) |
|-----------------------|----------------|-------------------------|-------------------------|---------------------------------|---------------------------------|
| +X, +Y | | | | | |
| +X, -Y | | | | | |
| -X, -Y | | | | | |
| -X, +Y | | | | | |
| TOTAL | | | | | |

$$X_{CG} (PEM) = (WT \times X_{CG})_{TOTAL} / WT_{TOTAL} = \underline{\hspace{2cm}} / \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$Y_{CG} (PEM) = (WT \times Y_{CG})_{TOTAL} / WT_{TOTAL} = \underline{\hspace{2cm}} / \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

5 QUALITY ASSURANCE

The Quality Assurance (QA) Engineer will ensure that all personnel involved in lifting, handling, and calculation are properly trained to this procedure. It is the responsibility of each individual involved in this operation to report anomalies discovered during in-process weighing to the QA Engineer. The QA Engineer will prepare a Problem Record (PR) and disposition each anomaly appropriately.